ONTROL
LTR NO
R # 4700 I
056 86

	ltr	E
RAL M E		
RMAN, H S		
RANCH D B		
CARNIVAL G J		
COPP R D		
DAVIS J G		
FERRERA D W		
HANNI, B J		
HARMAN, L K		
HEALY T J		
HEDAHL, T		
HILBIG J G		
HUTCHINS N M		
KELL R E		
KIRBY, W A		
KUESTER A W		
MAHAFFEY J W		
MANN H P		
MARX G E		
McDONALD M M		
MCKENNA F G		
MONTROSE J K		
MORGAN R V		
POTTER G L		
PIZUTTO G L		
RISING T L		
SANDLIN, N B		
SETLOCK G H		
STEWART D L		
STIGER S G		
SULLIVAN M T		
SWANSON E R		
WILKINSON R B		
WILSON J M		
WYANT R D		
Busby, W S	X	X
Lake, D	X	
O'Rourke, T.P.	X	X
Mast, Ed		
CORRES CONTROL	X	X
ADMIN RECORD/080	(2)	X
TRAFFIC		
PATS/T130G		
CLASSIFICATION		
UCNI		
UNCLASSIFIED		
CONFIDENTIAL		
SECRET		

AUTHORIZED CLASSIFIER SIGNATURE
~~DOCUMENT CLASSIFICATION~~ REVIEW WAIVER PER ~~CLASSIFICATION OFFICE~~
DATE
IN REPLY TO RFP CC NO

ACTION ITEM STATUS
☐ OPEN ☐ CLOSED
☐ PARTIAL
LTR APPROVALS
ORIG & TYPIST INITIALS
tjr

RF 46469 (Rev 11/93)

EG&G ROCKY FLATS

000031437

EG&G ROCKY FLATS, INC
ROCKY FLATS PLANT, P O BOX 464, GOLDEN, COLORADO 80402 0464 • (303) 966 7000

May 18, 1994

94-RF-05686

Frazer R Lockhart
Acting Director
Environmental Restoration Division
DOE/RFFO

Attn Jen Pepe

RESPONSE SUMMARY FOR COMMENTS ON OPERABLE UNIT NUMBER 11 FIELD SAMPLING PLAN TECHNICAL MEMORANDUM – WSB-054-94

This letter transmits 1 copy of the enclosed Technical Memorandum, Revised Field Sampling Plan for Operable Unit 11

If you have any questions regarding this transmittal, please contact K K O'Neill of Remediation Project Management at extension 8589

W S Busby
Director
Remediation Project Management

KKO tjr

Orig and 1 cc – F R Lockhart

Enclosure
As Stated

ADMIN RECORD

A-OU11-000127

CDH Comments

General Comments

1 1st paragraph Better justification for the number of surface soil samples has been made in Appendix E and is attached to this response summary

2nd paragraph The portion of the DQO section discussing the null hypothesis has been rewritten The revised DQO section is attached

3rd through 5th paragraphs Appendix E has been rewritten and is attached

6th paragraph Four new surface soil sampling locations have been added at locations of pipe junctures as those are the most likely areas at which hot spots may be found The revised map is attached

2 Wording in the FSP TM concerning subsurface soils has been changed to

> "Two foot composites will be collected to a depth of twelve feet From twelve feet to the saturated zone, six foot composites will be taken If a clay layer or zone of perched water is encountered, that section will be sampled discretely"

3 The primary objective for installation of the boreholes and monitoring wells in the FSP TM is to better characterize the vadose zone The DQOs will be changed to reflect this New locations for monitoring wells have been proposed (a map showing new locations is attached) A total of ten wells should provide coverage of 2,846,520 square feet (65 4 acres) at the WSF If a detectable zone of perched water with an area larger than 1000' in extent exists, it should be identified as a result of the sampling matrix presented If a perched water zone or clay layer is not encountered, the wells will be completed in the saturated zone, monitored for four quarters, and abandoned if contamination is not present in the groundwater The text in Section 4 will be modified to reflect these changes in approach and scope Geophysical logging (gamma gamma density and neutron) will be performed on all existing (17) and proposed (10) monitoring wells that affect the OU 11 investigation

Specific Comments

1 A statistical review using the Gilbert method was performed for OU 11 data and was presented in the original (draft) version of the OU 11 FSP TM The Environmental Protection Agency felt that this type of comparison was only appropriate for an RFI/RI Report and should not be used to make determinations for an FSP Those tables were removed and only basic data comparing contaminant means remain in this FSP (Table C) The words "rigorous statistical" were removed from the executive summary DOE understands that a rigorous review is required to determine COCs and will do so when data from the fieldwork returns from analysis

2 The organizational chart has been removed from the TM

3 Page 2-2, first paragraph of Step 1 and page 2-3, second paragraph have been changed to reflect that three media of concern exist, groundwater in the vadose zone, surface soils, and subsurface soils

4 Wording in the last paragraph on page 2-3 has been changed to

> "The primary goal of the FSP is to collect data to determine potential level of suspected contaminants so that risk can be assessed"

5 The "Action Levels" paragraph has been changed to

> "PCOC identification will be based upon comparisons to background using the Gilbert test methodology (Gilbert, 1993) Analytes identified as being elevated with respect to background will be considered PCOCs
>
> Action levels for PCOCs will be ARARs or PRGs"

6 Step 6 has been changed to

> "Decision error rates are based on consideration of the consequences of making incorrect decisions Decision error rates are used to establish appropriate performance goals for limiting uncertainty Establishing acceptable error rates is necessary prior to determining the appropriate performance goals for limiting uncertainty Establishing acceptable error rates is necessary prior to determining the appropriate number of data (samples or tests) necessary to support the decision with a specified level of confidence given potential effects on cost schedule, resource expenditure, human health, and ecological conditions (EPA 1993c)
>
> Type I errors (false positive) occur when the null hypothesis is incorrectly rejected This occurs when a statistical test determines that significant contamination occurs at OU 11 when it actually does not Type II errors (false negatives) occur when the null hypothesis is incorrectly accepted This occurs when a statistical test determines that significant contamination does not exist at OU 11 when it actually does The power of a statistical test is defined as one minus the Type II error and is the ability of the test to correctly reject the null hypothesis when it is false
>
> Probability values assigned to Type I and Type II error rates where chosen to reflect the acceptable probability for the occurrence of decision errors These were chosen as 20 percent for the false positive decision error (Type I error) and 5 percent for the false negative decision error (Type II error) This results in a statistical power of 0 95 to correctly reject the null hypothesis when it is false A more detailed discussion of error rates and statistical assumptions is presented in Appendix E"

7 It is understood that the depth intervals in the site-to-background comparisons aren't appropriate for the RFI/RI Report Those comparisons were made to provide a cursory look at the data only A paragraph was added after the first paragraph on page 3-1 the reads

> "Data for soils sampling at OU 11 have not been validated Test pit data will only be used for cursory comparisons to background No other data exists for comparison purposes The surface soil sampling program is based upon statistical power considerations and knowledge of historical operations at the WSF "

All references to Pu and Am in Rock Creek data have been removed, including those in Appendix C

8 Verbiage concerning VOCs in groundwater in Section 3 has been revised to read,

> "Within the WSF, detection of volatile organic compounds in groundwater has been inconsistent and extremely limited During 1991, the only VOC detected was toluene from well number 4986 only in the fourth quarter For 1992, xylene was detected in well number B110889 during the fourth quarter The analyte most frequently detected was methylene chloride, a common laboratory contaminant Detections of methylene chloride occurred only in the second quarter of 1993 from wells 46292 and 5086 Acetone was detected in the third quarter of 1993 in groundwater from well B410789 These detections were not repeated in subsequent quarters of 1993 and are not considered to be indicative of contamination "

Verbiage concerning radionuclides in groundwater has been revised to,

> 'Within IHSS 168, uranium-238 was detected in wells 4986 (third quarter only) and B410789 (first and second quarters) in 1991 Uranium-233/234 was detected in well B410789 for the first and second quarters of 1991 Plutonium and americium were found in upgradient well 5186 in the second quarter For 1992, well number 5086 showed levels of americium and plutonium in the first quarter only Americium was also detected in well 4986 in the third quarter Well B410789 had americium, uranium-238 and uranium-233/234 in the first quarter In 1993, the only radionuclide to exceed background values was radium-228 in the first quarter at well number 5086 Other radionuclides detected in 1993 were strontium, radium-226, uranium-233/234, 235, and 238, tritium, and plutonium "

9 A chart has been added to the TM that details the HPGe values in picoCuries/gram for each survey location (attached)

10 Nitrates have been added to subsurface soil analytical requirements

It is recommended that volatile and semi-volatile organic compounds be analyzed for qualitative values only in subsurface soils The reasons are

- The method of application at OU 11 was spray irrigation designed to enhance evaporation and would have volatilized most, if not all VOCs,

- VOCs are not consistently detected in the RCRA groundwater monitoring report When they were detected, they were considered laboratory contaminants due to the variation of types of VOC, the different wells they're found in, and detection levels either at or very near detection limits

- VOCs may be driven off by the heat generated from sonic drilling If VOCs are detected in subsurface soils, qualitative values for VOCs will be analyzed for

<u>EPA Comments</u>

<u>Response to Comments on Draft TM</u>

- The executive summary has been revised to accurately reflect the current fieldwork (see EPA Specific Comment Number 1)

- The HPGe survey no longer appears as proposed fieldwork

- It's not the intent of this TM to provide technical details of the HPGe system Information concerning the OU 11 survey and a reference to the "Compendium of In Situ Radiological Methods and Applications at Rocky Flats Plant," which is a regulatory agency approved document, was provided in the OU 11 FSP TM

- It is assumed that the reference in EPA's comments to an RFI/RI means an RFI/RI Report The comparison to closure standards has been removed

- The proposed OU 11 field investigation presented in this FSP attempts to quantify the extent and locations of potential aquitards and subsequent perched water The latest revision of the FSP includes placement of monitoring wells in order to locate aquitards and perched water that are 1000' or more in extent If the perched zone is less than 1000', it will be considered discontinuous and potential contamination would migrate into the saturated zone and would be detected by the existing and proposed wells in the network All proposed and existing wells will be geophysically logged to assist in the determination of the presence of clay lenses and to enhance characterization of the vadose zone

- Existing wells will be geophysically logged and are currently monitored and samples are taken under the RCRA groundwater program Analytes and sampling times are listed in the RCRA Groundwater Monitoring Report

General Comments

1 It is realized that sample depths differ, but for the RFI/RI Report, only sample depths that are similar will be compared This type of analysis will limit data comparability, therefore OU 11 intends to utilize sitewide PRGs for future comparison analysis

2 An additional four boreholes and monitoring wells have been proposed in the FSP (reference attached map) As mentioned in bullets above, one of the goals of characterizing the vadose zone is to determine if perched water zones larger than 1000' are present under the WSF (please see CDH General Comment Number 3) Placement of the new monitoring wells will also assist in vadose zone characterization and more extensive monitoring of the saturated zone as the wells will be completed there if perched water can't be found

3 The addition of four more boreholes and monitoring wells should adequately address this comment

4 • See the attached map of new monitoring well locations The combination of additional and existing wells provides five wells downgradient from Spray Area 1, 3 downgradient from Spray Area 2, and 2 downgradient from Spray Area 3

- An additional borehole/monitoring well location has been added to the proposal in the recommended location

- The logic for placement of the well includes the location of the seismic line An attempt is being made to determine if data from the seismic study is useful for shallow geologic characterization by verifying the calibration of shallow data The location is also appropriate because, if an area of perched water exists beneath Spray Area 1, the effect of mounding could have caused some of the contamination to migrate to the west It is possible that this is the source of the nitrate levels in well number 5186 This was not stated clearly in the TM Please see response to specific comment number 6 for change of verbiage in the FSP TM

Specific Comments

1 The last portion of the Executive Summary now reads

"The fieldwork proposed consists of

- Vadose zone investigations (includes borehole sampling and monitoring well installation) to assess the nature and extent of potential contamination and to assess the viability of this medium as a contaminant transport pathway or source and,

- A surficial soil sampling program to verify HPGe results and determine if levels of contamination that would be of risk to human health and the environment exist at OU 11

Fieldwork that has already been accomplished in accordance with the original OU 11 Work Plan (EG&G 1992a) consists of,

- Ecological field sampling, including surveys to support a statistical evaluation of the potential for impacts to the ecology,

- A focused High Purity Germanium (HPGe) field screen for potential radiological contamination on the surface "

2 For modeling purposes, the extent of the semi-pervious clay layer is assumed to be infinite In the analytical model, the lateral extent of the semi-pervious layer does not determine the location and height of perched groundwater The mound thickness is a function of the clay layer thickness, hydraulic conductivities, and width of the area of spray application These parameters are provided The assumption relative to clay layer extent will be added to Appendix B Please also see the fifth bulleted item in the beginning of EPA comment responses for additional support of vadose zone characterization

3 Please see the response to Specific Comment Number 6 in CDH comment responses

4 The title of Figure 3-1 has been changed to "Sample Locations for Previous Investigations at OU 11 and Background Studies " Wells that were not included on the map were not used in the comparison study because either they were abandoned or data was not available from RFEDS at the time the statistics were run

5 In Section 4, the first paragraph under the "Subsurface Soil (Sediment) Sampling Plan" has been changed to,

> "Subsurface soils will be sampled from the monitoring well locations described in Section 4 5 and Figure 4-2 Two foot composites will be collected to a depth of twelve feet From twelve feet to the saturated zone, six foot composites will be taken If a clay layer is encountered, that section will be sampled discretely If perched water is encountered, equipment for monitoring groundwater will be installed at the depth of perched water Approximately 120 borehole samples will be taken using this sampling strategy Section 4 5 details sampling methodology "

On page 4-10, the second paragraph has been changed to,

> "For the purpose of defining extent of potential vadose zone contamination, soil samples will be collected from ground surface to the saturated zone At each boring location, two-foot composite samples for chemical analyses will be collected from ground surface to a depth of 12 feet and six foot composites will be taken from 12 feet to the saturated zone with discrete samples taken at locations where perched water is located If perched water is not encountered at or before 30 feet, then the well will be completed in the saturated zone Figure 4-3 summarizes the drilling decisions and subsequent activities flow "

6 As mentioned earlier, if perched water exists beneath Spray Area 1, the effect of mounding would have caused some of the contamination to migrate to the west It is possible that this is the source of the nitrate levels in well number 5186 This was not stated clearly in the TM The following has been added to the end of the third paragraph in Section 4 5

"The screened intervals of the wells in the current monitoring system are either too deep to monitor perched conditions, or are screened through the entire thickness of the RFA The three wells with extensive screened intervals are 4986, 5186, and B410789 Well number 5186 is upgradient of Spray Area 1, but may been contaminated with nitrates from OU 11 due the mounding effect of perched water from spray activities The nitrate/nitrite concentrations in the three wells do not constitute a concern in terms of nitrate/nitrite groundwater standards (10 mg/L), (EPA 1993b), however, they may represent a dilution of shallow (perched) groundwater contamination with deeper groundwater from the saturated zone"

7 This was an error Text describing the locations of the boreholes and monitoring well location has been changed to reflect corrections, new logic, and four new locations

WSF 1
- Provides northwest area coverage
- Located beneath historical pipeline location

WSF-2
- Near well 5186, where elevated nitrate concentrations have been recorded
- On seismic line

WSF-3
- Fills in area of insufficient data
- On historical pipeline location

WSF-4
- Provides coverage of northernmost area of Spray Area 2

WSF-5
- Near well #4986, where the highest level of nitrate/nitrite was recorded
- On the seismic line

WSF-6
- Centrally located in Spray Area 3, where there is a lack of data

WSF-7
- Provides coverage of the southwest corner of OU 11
- On historical pipe location

WSF-8
- Provides coverage in the south central portion of the WSF

WSF-9
- Fills in data gap in the direction of groundwater flow from Spray Area 1

WSF-10
- Provides coverage in the southeast area of the WSF

8 Nitrates will be added to the list of subsurface soil analytical parameters

9 The last sentence in the second paragraph in Section 5 1 has been changed to

"Trip blanks will be included in sample shipments containing samples for VOC analysis"

10 Section 5 2 has been changed to

> "Accuracy is a measure of the closeness of a reported concentration to the true value Analytical accuracy is expressed as percent recovery of a spike of a known concentration that has been added to an environmental sample before analysis The control limits that have been established to achieve accuracy objectives for CLP Level IV data are outlined in Appendix B of the QAPjP (EG&G 1992b) Accuracy limits for inorganic analytes are listed in this table as well The OU 11 QC criterion for acceptable percent recovery in CLP Level IV data is 80 percent to 120 percent for all analytes in all media Samples requiring 24-hour turnaround (that is, indicator parameter analyses) have accuracy objectives consistent with CLP Level II data quality The analyses for indicator parameters are non-CLP Non-CLP analyses will be conducted according to SW-846 (EPA 1990) The accuracy criteria for these samples are specified in the respective methods "

Section 5 3 has been changed to

> "Precision is a quantitative measure of variability that is evaluated by comparing analytical results for real samples to analytical results for corresponding duplicate samples Analytical precision for a single analyte is expressed as the Relative Percent Difference (RPD) between results of duplicate samples (and matrix spike duplicates) for a given analyte RPDs indicate the degree of reproducibility of both the sampling and analysis methods The control limits that have been established to achieve precision objectives for CLP Level IV data are outlined in Appendix B of the QAPjP (EG&G 1992b) Precision limits for inorganic analytes are outlined in this Appendix as well The analysis for indicator parameters are non-CLP Non-CLP analyses will be conducted according to SW-846 (EPA 1990) The precision criteria for these samples are specified in the respective methods For the OU 11 data, acceptable RPDs are less than 20 percent for all analytes in water and less than 35 percent for all analytes in soils "

11 Please see Table 5-1, attached

12 Please see Table 5-1, attached

13 For soils, "Nitrates" on Table 5-2 has been changed to "Nitrate/Nitrite" and the holding time has been changed from "As Soon As Possible to "28 days " The preservative has been changed to H_2SO_4, pH<2

14 The terms "a" and "c" are defined by the equations These are intermediate values in the mathematical process

15 The last sentence in the third paragraph on page B-4 now reads

> "The line of section for the mound is also shown on the map of the West Spray Field in Figure 4 2 in Section 4 of this TM "

16 The figure will be corrected The correct mound height is 0 97 feet

17 Please see the revised Appendix E, attached

General Comments from 4/21/94 meeting

- An analysis of the lithologic data from previous borings was conducted, however because percussion hammer drilling technology was used, lithologic logs lack detail and accuracy Percussion drilling technology provides an effective method for drilling through the thick gravels underlying the West Spray Field, but it does not provide for the collection of continuous core, as do other drilling methods commonly used at Rocky Flats

Subsurface materials generated during previous drilling operations were cuttings, and were collected every five feet These were logged in accordance with RFP protocol, but the logs can be used in only a qualitative manner Representativeness of the samples is highly questionable, and descriptions were generalized over five-foot intervals Percussion drilling was utilized for all of the wells in and near OU 11, with the exception of the shallow portion of Borehole B411389 In this case hollow stem auguring and continuous split spoon sampling was employed

Existing bore logs do not provide the necessary detailed data for documentation of perched water zones The drilling method (sonic drilling) described in the revised field sampling plan produces continuous core for logging and analysis purposes

- A potentiometric surface map will be included in the FSP In the review comments, the groundwater gradient beneath the West Spray Field is assumed always to be from west to east The gradient in the saturated zone is west to east with a strong vertical component, however one should not simply assume that the gradient in perched mounds is the same as that in the saturated zone Often perched mounds affect local gradient reversals

The review comments state that elevated nitrate/nitrite concentrations in Well 5186 cannot be attributed to West Spray Field activities because it is approximately 200 feet upgradient Groundwater professionals in the RFP Geoscience Department are aware of the location of Well 5186, and it is the consensus of those professionals that the elevated nitrate/nitrite concentrations at location 5186 are the result of spray application In a perched groundwater system, this makes good hydrogeologic sense

- The last attachment to this response summary is an explanation of why available seismic data was not used to support the OU 11 FSP

APPENDIX E
STATISTICAL JUSTIFICATION FOR THE REVISED OU 11 SURFACE SOIL SAMPLING PLAN

The agency approved methodology for statistically comparing site to background data to identify site contamination, referred to as the Gilbert test methodology, consists of six statistical test including the Slippage test, Quantile test, Wilcoxon Rank Sum (WRS) test, Gehan test, t-test (if the data are normally distributed), and a hot measurement test (EG&G, 1994) At the present time, no statistical methodology exists for determining the combined power of the entire Gilbert test methodology to detect site contamination given a specified number of samples from both the site and background areas However, a methodology does exist for determining the power of two of the tests, the Quantile and WRS tests, to detect site contamination and is presented in *Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3*, (Gilbert and Simpson, 1992) This methodology was used to estimate the number of samples necessary to compare surface soil data from Operable Unit 11 (OU 11) to background. The objective of this approach was to determine the most resource-effective sampling design to satisfy DQOs.

The statistical methodology presented in the original FSP-TM preceded the Gilbert methodology and the EPA guidance document on the DQO process In the second version of the FSP-TM, an approach was presented based on qualitative statistical discussions indicating that the original sample size could be reduced due the nature of contamination likely present at OU 11 Neither of these methodologies were incorrect, however, they are being abandoned in favor of an approach more consistent with current EPA guidance

To determine the sample size necessary to achieve a specified power, we must specify the variability of the populations to be compared, the minimum detectable difference, Type I error rate, and the statistical test to be used Any sample size calculations will be specific to these conditions and will not apply if they change. Therefore, sample size calculations based upon normally distributed data and a simple t-test will not correctly predict the sample size necessary to achieve the same level of power using non-normally distributed data and the nonparametric tests specified in the Gilbert methodology

Sample size calculations were performed for two of the nonparametric tests (Quantile and Wilcoxon Rank Sum) specified in the Gilbert test methodology. The Wilcoxon Rank Sum (WRS) test is equivalent to the Gehan test when only one detection limit for nondetected values is reported in the data Evaluating the performance of these tests provides a means of estimating the power of the Gilbert test methodology to detect site contamination at OU 11 The combined power of the entire Gilbert test methodology to detect contamination should be greater than the individual power of any single test Therefore, these calculations represent conservative estimates of the power of the Gilbert test methodology to detect contamination at OU 11.

The Quantile and WRS tests are designed to detect different types of site contamination. When a small area of the site contains high levels of contamination (e g , three standard deviations above the mean), the Quantile test will have more power than the WRS test to detect this contamination However, when the level of contamination is small (e g , one standard deviation above the mean) and the contamination is widespread throughout the site, the WRS test will have more power than the Quantile test The use of both tests is recommended to detect both types of contamination (Gilbert and Simpson, 1992) However, the use of both tests does increase the probability of incorrectly determining contamination exists when it actually does not

The null and alternative hypotheses for the Quantile and WRS tests are stated as (Gilbert and Simpson, 1992)

H_0: Reference-Based Cleanup Standard Achieved

H_a Reference-Based Cleanup Standard Not Achieved

The hypotheses stated above are the opposite of those used to compare site data to risk-based cleanup standards or ARARs This approach was adopted because stating the null hypothesis as the reference-based standard has not been achieved would require most site measurements to be less than reference measurements before determining that the standard has been achieved. The hypotheses stated above were also used in USEPA (1989, p.4-8) to test for differences between contaminant concentrations in a reference area and a site of interest

The Type I error rate (α) for this test is defined as the probability of incorrectly determining that the site exceeds background The Type II error rate (β) is defined as the probability of incorrectly determining that the site does not exceed background when it actually does The Type I and Type II error rates were set at 0 20 and 0 05, respectively during sample size calculations for both the Quantile and WRS tests

Sample size calculations for the WRS followed the methodology presented in Gilbert and Simpson (1992). It is assumed in these calculations that all data collected during the field program will be useable for statistical testing The equation for calculating the number of samples to collect from the reference site and clean-up unit when the distribution of the data is unknown is

$$N=\frac{(Z_{1-\alpha}+Z_{1-\beta})^2}{12c(1-c)(P_r-o\,5)^2} \qquad (1)$$

where

N	=	total number of required samples (site plus background)
α	=	specified Type I error rate
β	=	specified Type II error rate
$Z_{1-\alpha}$	=	value that cuts off $(100\alpha)\%$ of the standard normal probability distribution
$Z_{1-\beta}$	=	value that cuts off $(100\beta)\%$ of the standard normal probability distribution
c	=	specified proportion of the total number of samples, N, that will be collected in the reference area (specified as 0.5 when one site is being compared to background)
P_r	=	specified probability greater than 1/2 and less than 1.0 that a measurement collected at a random location in the cleanup unit is greater than a measurement of a sample collected at random in the reference area (see discussion below)

A value of the probability, P_r, must be specified when calculating sample sizes for the WRS test using the equation given above However, it may be difficult to understand what a specific value of P_r actually means in terms of the relative difference between the two populations to be detected. Rather than directly specify P_r, it may be easier to specify the relative shift (Δ/σ) in the site concentration distribution to the right (to higher values) of the reference distribution to be detected with a given power. Values of P_r for different relative shifts of the site distribution to the right of the reference distribution are given in Gilbert and Simpson (1992, p. 6 12) A relative shift of 0 95 standard deviations corresponding to a P_r of 0 75 was used during sample size calculations for the WRS test This means that the sample size calculated will detect site concentrations greater than background when the site concentration distribution is 0.95 standard deviations to the right of the reference area concentration distribution with the power specified in the test (0 95)

Using the parameters specified above (α = 0 20, β = 0 05, and P_r = 0 75) in equation 1 results in a total sample size (site plus background) of 33 This requires 17 samples to be collected from the unit being compared to background (OU 11) and 17 samples from the background unit itself

Sample size calculations for the Quantile test were also conducted using the methodology given in Gilbert and Simpson (1992). To determine the sample size necessary to detect site contamination with a given power, we must specify the relative shift (Δ/σ) of the site concentration distribution relative to the background concentration distribution and the percentage of the site (ϵ) that is contaminated Tables for determining the power associated with different combinations of Δ/σ, ϵ, and α are given in Appendix A of Gilbert and Simpson (1992) Since the Quantile test is more effective than the WRS test in detecting site contamination when only a portion of the site is highly contaminated, sample size calculations were conducted for a relative shift of 3 0 standard deviations within 40 percent of the site data. Since a table was not given for a Type I error rate of 0 20, a Type I error of 0.10 was used as a conservative approximation This resulted in a power of 0 956 for sample sizes of 20 for both the site and background data

Summary

Sample size calculations for the WRS and Quantile test were conducted using procedures given in Gilbert and Simpson (1992) The power of each test to detect site contamination was chosen as 0 95 The combined power of the entire Gilbert test methodology to detect contamination is probably greater than the power of any of the tests individually, however, methods for addressing the power of the entire Gilbert test methodology do not exist at this time. Therefore, a more conservative approach was adopted using existing methods.

The results of the sample size calculations indicate that 20 samples are necessary to adequately characterize surface soils at OU 11. This represents a conservative estimate of the minimum sample size to meet the DQOs set forth in this document However, based upon hydrologic consideration and our understanding of past operations at OU 11, a larger sample size of 38 was chosen This provides enough data to meet the statistical objectives of the DQOs and provides additional protection against incorrectly determining the site is not contaminated when it actually is

2 0 DATA QUALITY OBJECTIVES

The U S Environmental Protection Agency (EPA) has established a 7-step process to SUPERFUND decision-making as the basis for developing DQOs (EPA, 1993a) DQOs are quantitative and qualitative statements that are established to ensure that the type, quality and quantity of the data are optimized for accomplishing the purpose of the project The DQOs will,

1 clarify the study objective,
2 define the most appropriate type of data to collect,
3 determine the most appropriate conditions from which to collect the data, and,
4 specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision (EPA, 1993a)

For the OU 11 project, the intended use of the data includes human health and ecological risk assessment Analytical results will be compared with background RFP values, risk-based calculations, and Applicable or Relevant and Appropriate Requirements (ARARs) If required, the data will also be the basis for corrective measure design In addition, precision, accuracy, representativeness, comparability, and completeness (PARCC) are DQOs set forth in the EPA Guidelines (EPA, 1987), DOE Data Management Requirements (DOE, 1993), and the Quality Assurance Project Plan (QAPjP) (EG&G, 1992b)

2 1 Data Quality Objectives Process

The DQO process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application (EPA, 1993a) The DQOs are statements derived from an iterative 7-step process that streamlines the study so that only those data needed to make a decision are collected and used The process consists of the following seven steps

1 State the Problem
2 Identify the Decision
3 Identify Inputs to the Decision
4 Define the Study Boundaries
5 Develop a Decision Rule
6 Specify Limits on Decision Errors
7 Optimize the Design for Obtaining Data

Step 1 State the Problem

The WSF at the RFP has been exposed to waters originating from the ITS and the Solar Evaporation Ponds and, with process knowledge, the risk to human health and the environment is unknown and must be determined Possible contamination is from radionuclides, metals, and major anions A hydrogeologic conceptual site model was developed for the OU and is presented in detail in this section Due to the lack of data concerning groundwater in the upper portion of the upper hydrostratigraphic unit (Figure 2-1), this media will be one of the primary concerns of the OU 11 investigation presented in this FSP Media of concern also include surface and subsurface soils

Several types of environmental specialists are needed to implement the DQO process The planning team consists of a project manager and lead, a hydrogeologist, two statisticians, at least three risk assessors, a geologic engineer, quality assurance personnel, and two biologists The primary decision makers consist of representatives from the Colorado Department of Health (CDH), EPA, DOE and EG&G Project Management for OU 11

Conceptual Site Model

The function of the WSF conceptual model is to describe the site and its environs and to present hypotheses regarding contamination (or potential contamination), routes of migration, and potential impact on receptors The original Phase I RFI/RI Work Plan for OU 11 presented a conceptual model that included a description of the contaminant source, release mechanisms, transport medium, contaminant migration pathways, exposure routes, and receptors The Hydrogeologic Conceptual Model (Figure 2-1) takes the modeling process one step further by presenting potential migration pathways in a geologic setting The primary release mechanisms for contaminants from the WSF are fugitive dust, surface-water runoff, infiltration and percolation of groundwater, bioconcentration/bioaccumulation, and tracking The possible exposure pathways for contaminants resulting from spray application include ingestion, inhalation, and dermal contact of the contaminated soil, groundwater, and/or surface water

Surficial and shallow soils, which received waste water through direct application and surface runoff, are recognized as media of concern for potential contamination However, historical analytical results show most contaminant concentrations in these media are below background levels (Section 3 3) Soil characterization activities and recommendations relative to previously collected data are presented in Sections 3 0 (Summary of Existing Data) and 4 0 (Sampling and Analysis Plan) of this TM

The upper portion of the upper hydrostratigraphic unit has not been thoroughly investigated The media of concern that received the most attention historically were shallow soils, surface soils, and the saturated zone (the lower portion of the upper hydrostratigraphic unit) Relatively little attention has been given to potential perched water zones resulting from spray application This perched system is thought to exist for the following three reasons,

1 **Historical Monitoring Data**

The following wells were drilled for the purpose of monitoring shallow groundwater in the unsaturated zone 1081, 0782, 0582, and 0682 RFEDS contains water level data collected quarterly from January, 1987, through July, 1992 These monitoring data demonstrate that the measured depth to water in all wells was around 20 feet, approximately 40 feet above the saturated zone water table Well data show that the depth to perched water has increased with time following the period of spray application For example, water level measurements for well 1081 indicate that the depth to water in July, 1987 was 17 3 feet, whereas the depth to water in July, 1992 was 22 6 feet

From available water-level data we cannot determine perched zone thicknesses, because well completion details and lithologic data are not available We can observe that the thickness of the perched zone has systematically decreased following spray application

Nitrate/nitrite RFEDS chemical data for the above referenced wells are mostly not validated, however they demonstrate that initial high concentrations of nitrate/nitrite dissipated quickly following spray application The table below lists some of the data from two different locations in and near OU11

Well 1081	Nitrate/Nitrite Concentrations
August, 1986	22 1 mg/l
August, 1987	7 8 mg/l

July, 1991	4 4 mg/l - (validated)
April, 1992	2 7 mg/l -- (validated)
Well 0682	Nitrate/Nitrite Concentrations
August, 1986	22 1 mg/l
August, 1987	0 28 mg/l
August, 1991	0 3 mg/l -- (validated)

Data supports that nitrate/nitrite concentrations in perched ground waters at these two OU11 locations are relatively insignificant, however these perched conditions are not under the areas that received maximum spray application The purpose of the Revised Field Sampling Plan is to elevate contamination concentrations under the areas which received maximum spray application If perched conditions are not present there, then concerns relative to groundwater contamination are relatively minor

2 Soil Moisture Encountered During Drilling

In 1992, wells 1081, 0782, 0582, and 0682 were abandoned as part of the Well Abandonment and Replacement Program (WARP) Replacement wells, 46192 and 46292, were drilled utilizing air-fluid percussion technology Moisture characteristics of the well cuttings exhibited vertical variations consistent with perched groundwater conditions

3 Elevated nitrate levels in wells screened throughout the uppermost hydrostratigraphic interval

As stated on page 4-4 of the sampling plan, screened intervals of wells in the current monitoring system are either too deep to monitor perched conditions or are screened through the entire thickness of the Rocky Flats Alluvium Three wells with extensive screened intervals (from near surface to the base of the uppermost hydrostratigraphic unit) include 4986, 5186, and B410789 During the past several years, nitrate/nitrite has been detected in all three wells at concentrations higher than the sample mean These concentrations range from approximately 3 to 8 mg/l, whereas the sample mean is 1 7 The interpretation that elevated concentrations are the result of contributing shallow perched waters to the overall groundwater system is reasonable Perched water zones would have a greater potential of retaining contamination than the lower portion of the upper hydrostratigraphic unit due to the proximity of spraying operations Therefore, the potential for a perched water system to exist and accumulate contaminants will be investigated

Hydrogeologic Conceptual Model

The goal of the FSP is to collect data so that the potential of risk from current contamination levels can be determined Previous soil and groundwater investigations do not indicate that significant levels of contamination exist in OU 11 (Appendix C) Data collected from wells constructed to evaluate only the saturated zone of the uppermost hydrostratigraphic unit indicate that concentrations for individual contaminants are insignificant However, elevated levels of some contaminants, specifically nitrates, have been detected in wells which were screened to evaluate the entire (saturated and unsaturated) uppermost hydrostratigraphic unit at OU 11 (Figure 2-2) It is hypothesized that these elevated levels are the result of the contribution of contaminated perched groundwater mounds to the overall shallow groundwater system (evidence for perched groundwater conditions is further discussed in Section 4 5) To date, characterization of shallow subsurface lithologies and water chemistries is incomplete

At the WSF, the uppermost hydrostratigraphic unit is the Rocky Flats Alluvium (RFA), a heterogeneous alluvial fan deposit consisting of unconsolidated gravels, sands, and clays with the water table at a depth of approximately 50 feet As previously discussed, the probable existence of perched water in the vadose zone is of primary concern for potential groundwater contamination

Figure 2-1 is a conceptual model for shallow groundwater mounding, which is proposed as a hypothesis to be evaluated Spray application of water occurred during several years as a waste management activity Surface runoff, evapotranspiration, and infiltration occurred during that time, and infiltrated water recharged the alluvial hydrostratigraphic unit to a small extent In addition, water may have accumulated over semi-pervious clay layers or lenses of lower vertical hydraulic conductivity Finally, when spraying ceased, the amount of water that was perched began to diminish due to continued downward migration and evapotranspiration If contaminants were present, they may still exist in these perched zones either as dissolved constituents or precipitates

As explained above, historical water level data and recent drilling reports indicate that perched water conditions may exist under portions of OU 11 Evidence for perched conditions is discussed in detail Section 4 5 where justification of monitoring well locations is also presented If groundwater has become contaminated to significant levels above background because of spray application, perched water, by virtue of its proximity to the surface of application, would have the potential for containing elevated levels of contamination The migration of contaminated perched groundwater could constitute a potential health risk To date, the characterization of vadose zone geology and water chemistry is incomplete As previously mentioned, most monitoring wells in the WSF were designed to monitor the saturated zone of the uppermost hydrostratigraphic unit In addition, because of the presence of large cobbles and boulders in the alluvial gravels, most of these wells were drilled using percussion technology Lithologic descriptions of the collected cuttings lack accuracy and detail Therefore, for this investigation, subsurface lithologies, as well as borehole and groundwater chemistries will be characterized (in accordance with Section 4 6, Analytical Requirements) Seismic data were not utilized for the selection of the drill sites However lithologic data collected from the FSP will be used as an aid in calibrating the seismic data to the subsurface geology

Mathematical Modeling of Perched Groundwater Mounds

For preliminary planning purposes, mathematical analytical modeling was performed Using a method documented by Brock (Brock, 1976), a hypothetical two dimensional mound profile under WSF Area 1 was developed Appendix B shows the model calculations used to predict mound height and extent Parameters used in the model were in accordance with field data collected in other areas of RFP and professional judgement Hydrologic assumptions relevant to the model are similar to those inherent in various groundwater models and are explicitly stated This model was specifically used to provide a rough "order-of-magnitude" analysis of anticipated perched groundwater mound height Modeling results suggest that perched mounds resulting from spray application would be relatively thin, with the calculated steady state mound height under Spray Area 1 being approximately seven feet

Step 2 Identify the Decision

The Decision

A decision will be made as to whether the concentrations of the potential contaminants of concern are a risk to human health and the environment The analytical data that exceed background concentrations, ARARs, or Preliminary Remediation Goals (PRGs), will warrant further assessment and/or a response action

Actions as a result of the resolution of the decision.

A decision of no action is required if Potential Contaminant of Concern (PCOCs) for each medium individually do not exceed background values, ARARs or PRGs Further assessment and/or a response action will be conducted if action levels are exceeded For example, if levels of contamination are found that exceed threshold values, then further vadose zone characterization will be considered for analysis of the migration of contaminated groundwater as a source of significant risk If no perched water mounds are found or if levels of contamination are found below threshold values in shallow perched groundwater mounds, then no further characterization of the groundwater system will be deemed necessary

Step 3 Identify the Inputs to the Decision

Information that will be required to make the decision.

All historical analytical data collected from the 1988 test pits sampling, historical and current monitoring well activities, and process knowledge of the Solar Evaporation Ponds (quantitative and qualitative) will be compiled to identify the areal extent of contamination in order to determine the sample variance and sample mean of analytes from each media sampled over time at the WSF

To assess risk, this investigation will also include the examination of

- Groundwater flowpaths and hydraulic gradients of the upper aquifer
- Water levels, potentiometric surface, hydraulic gradient and potential clay lenses from previously installed wells
- Hydrological modeling input and out-put data to further identify the presence and extent of the perched water mounds that are indicative of the site

Information needed to identify the action level.

The action levels of the PCOCs will be determined by the regulatory agencies and will include consideration of background values, ARARs and PRGs

The appropriate sampling techniques and analytical methods used to obtain the data

EPA-approved field sampling techniques for sub-surface soil sampling, monitoring well installation, and groundwater sampling are listed in Section 4 5 of this TM The associated analytical parameters that will be used for the sampling are listed in Section 4 6 of this TM The analytical methods for each parameter are listed in Appendix B of the QAPjP (EG&G, 1992b) Table 2-1 summarizes the objectives, activities, uses, and analytical levels for this investigation

Table 2-1

OBJECTIVES AND ACTIVITIES OF THE REVISED FIELD SAMPLING PLAN

Objective	Activity	Data Type	Data Use
Determine if contamination exists in the Vadose Zone	1) Collect and analyze soil samples from borehole core	FIELD QUANTITATIVE	Site characterization Risk assessment Field decisions
	2) Install monitoring wells to collect and analyze perched groundwater if appropriate	FIELD QUANTITATIVE	
	3) Drill to saturated zone if perched water does not exist	FIELD	
Determine if contamination exists in surface soils	1) Obtain recent HPGe survey data and 1989 aerial gamma survey data	QUANTITATIVE	Site characterization Risk assessment Health and safety
	2) Collect and analyze surface soil samples	FIELD QUANTITATIVE	
Assess current ecological conditions	1) Compare current conditions to background	QUANTITATIVE	Site characterization Risk Assessment
	2) Determine the absence or presence of adverse impacts to the ecology	FIELD QUANTITATIVE	

Step 4   Boundaries

Spatial boundaries.

The investigation of OU 11 (IHSS 168) will focus on surface soils, sub-surface soils, and groundwater from perched groundwater mounds Sub-surface soil sampling will extend to the saturated zone and samples will be collected at two foot intervals (the upper five feet of the vadose zone is of particular interest) Groundwater will be sampled from monitoring wells finished in the boreholes

Characteristics that will define the population of interest.

The PCOCs for the baseline risk assessment, which are yet to be determined, will focus on surface soils, sub-surface soils, and groundwater The data collected will be compared to the established background analyte levels, relevant ARARs and PRGs

The scale of decision making.

Samples will be collected from surficial soils, subsurface soils (soil boreholes), and perched water mounds Separate decisions will be made for surface soils, each identified perched water mound, and the associated sub-surface soil and clay layers

Temporal boundaries.

In 1986 and 1988, soils studies showed that surface soils in the WSF do not pose an immediate threat to human health or the environment Similarly, no threat is indicated from RCRA groundwater monitoring, which has been conducted since 1988 Field work on OU 11 will begin as soon as the FSP is approved and is expected to take approximately one month Since the FSP combines the Phase I and Phase II programs for OU 11, the activities will be tightly focused, and an RFI/RI report will be completed several years ahead of the original IAG schedule

Practical constraints on the data collection.

The most important possible constraint on data collection is the ability to penetrate the RFA for thorough sample collection Because the RFA is heterogeneous alluvial material, standard drilling methods have proven inadequate for sample collection Use of a sonic drilling rig is proposed for future work, as it has worked well for other investigations in similar geologic materials

Step 5 Develop a Decision Rule

<u>Parameters that characterize the population of interest.</u>
PCOC concentrations will be specified as a characteristic or attribute with regards to minimum, maximum, mean, and/or as a variance that is relevant for each of the sampled media that will be compared to the pertinent threshold value

<u>Action levels for the study.</u>
PCOC identification will be based upon comparisons to background using the Gilbert test methodology (Gilbert 1993) Analytes identified as being elevated with respect to background will be considered PCOCs

Action levels for PCOCs will be ARARs or PRGs

<u>The decision rule for each population of interest.</u>
If the levels of contamination for each environmental media investigated are above threshold levels for the specific contaminants, then the media will be evaluated for further investigation and possible remediation

Step 6 Specify Limits on Decision Errors

Decision error rates are based on consideration of the consequences of making incorrect decisions Decision error rates are used to establish appropriate performance goals for limiting uncertainty Establishing acceptable error rates is necessary prior to determining the appropriate performance goals for limiting uncertainty Establishing acceptable error rates is necessary prior to determining the appropriate number of data (samples or tests) necessary to support the decision with a specified level of confidence given potential effects on cost, schedule, resource expenditure, human health, and ecological conditions (EPA 1993c)

Type I errors (false positive) occur when the null hypothesis is incorrectly rejected This occurs when a statistical test determines that significant contamination occurs at OU 11 when it actually does not Type II errors (false negatives) occur when the null hypothesis is incorrectly accepted This occurs when a statistical test determines that significant contamination does not exist at OU 11 when it actually does The power of a statistical test is defined as one minus the Type II error and is the ability of the test to correctly reject the null hypothesis when it is false

Probability values assigned to Type I and Type II error rates where chosen to reflect the acceptable probability for the occurrence of decision errors These were chosen as 20 percent for the false positive decision error (Type I error) and 5 percent for the false negative decision error (Type II error) This results in a statistical power of 0 95 to correctly reject the null hypothesis when it is false A more detailed discussion of error rates and statistical assumptions is presented in Appendix E

Step 7 Optimize the Design

Each media has a sampling plan designed to reduce decisions errors as much as possible For surface soil sampling, a biased approach based upon areas of highest spray and possible runoff is utilized and is presented in Section 4 3 Sample size calculations for surficial soils are presented in Appendix E For subsurface soils and groundwater, error is reduced by using data from previously installed wells in order to determine likely locations of perched water (logic for this assumption is presented in Section 4 0) Constituents for investigation are determined based on past investigations at the WSF, current groundwater monitoring data, and Solar Pond water process knowledge

2 2 Establishing the PARCC Parameters

The DQO process takes into account the validation of the sampling effort that is used to identify contaminants of concern (COCs) The process of collecting data and analyzing it to obtain usable, quality data that is defensible with respect to the actions taken at a site are based upon the PARCC of the data These primary analytical DQOs will be used to ensure that the data collected at OU 11 depicts the contaminant levels and the environmental conditions at the time of sampling Details on the calculations pertaining to PARCC are provided in Section 5

Precision

Analytical precision is expressed as a percentage of the difference between the results of duplicate samples for a given compound The Relative Percent Difference (RPD) for water samples will be 30% and for soils will be 40% The overall required percentage of samples to fall within the DQOs stated, per media and analytical suite, is 85%

Accuracy

Accuracy will be expressed in terms of completeness and bias Accuracy is a quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value The closer to the true value, the more accurate the measurement One of the measures of analytical accuracy is expressed as a percent recovery of a spike or tracer that has been added to the environmental sample at a known concentration before analysis (EG&G, 1991) Although it is not feasible to totally eliminate sources of error that may reduce accuracy, error will be minimized by using standardized analytical methods and field procedures

In addition, the accuracy of each instrument used that ultimately influences project decisions will be stated The correct resolution of reported results, and corresponding number of significant figures will be determined, and all of the corresponding measurements (or calculation results, e g , numerical model output) will be reported consistently This determination will be based on detection limits, for example, from General Radiochemistry and Routine Analytical Protocol (GRRASP) (EG&G, 1990) specifications, manufacturer's specifications, standard operating procedures, and or instrument-specific calibration data

Representativeness

Representativeness will be maximized by ensuring that sampling point locations are selected properly, potential "Hot Spots" are addressed, and a sufficient number of samples are collected over a specified time span All sampling will be conducted as outlined per this FSP and RFP Standard Operating Procedures (SOPs)

Completeness

The amount of usable data collected from the sampling program for all media will be calculated to ensure that the program meets the performance objectives for the study The goal for completeness is 100% with a minimum acceptance of 90%

Comparability

Sample data will be comparable with other measurements for similar samples (matrix types) and conditions The goal for comparability will be achieved by implementing sampling techniques and analytical methods outlined in the SOPs and reporting the results in appropriate units Comparability will only be performed with confidence when precision and accuracy are known and will be performed with respect to one or more of the following

1 protocols (e g , SOPs) used to collect and/or synthesize the samples
2 matrix types (e g , dry soil samples may not be comparable to saturated soil samples for "fate and transport" purposes)
3 temporal considerations (periodical, seasonal, event-related, etc)
4 spatial considerations (3-dimensional)

Data set comparison will (at least) include the comparison of real samples with

1 other real samples, as appropriate, and,
2 background data

OU 11 HPGe RESULTS
(DRAFT)

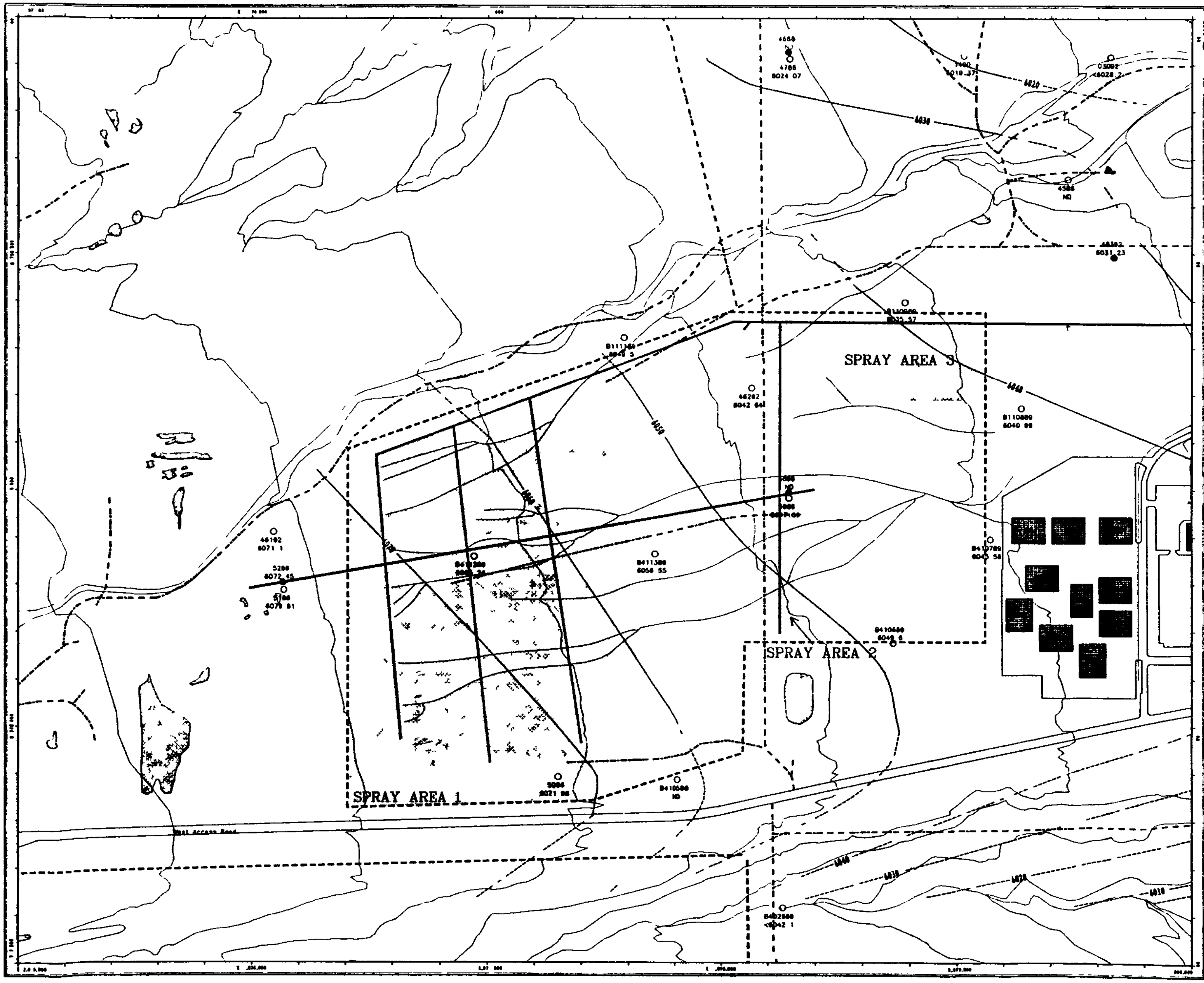
OU	Detector Array	Detector Height (m)	FOV (m)	Station	North (feet)	East (feet)	K-40 (pCi/g)	Ra-226 (pCi/g)	Th-232 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Cs-137 (pCi/g)	Am-241 (pCi/g)	Pu-239 (pCi/g)	Exposure (μR/h)	% FOV Blocked
11	4A6	6 5	44	I8	749200	2076700	7 48	0 827	1 09	1 66	0 0684	0 466	0	0	6 19	0
11	4A6	6 5	44	K8	749000	2076700	7 72	0 832	1 15	1 79	0 073	0 529	0	0	6 25	0
11	4A6	6 5	44	M8	748800	2076700	8 26	0 859	1 28	2 04	0 0775	0 556	0	0	6 67	0
11	4A6	6 5	44	O8	748600	2076700	8 41	0 846	1 31	1 96	0 0959	0 572	0	0	6 89	0
11	4A6	6 5	44	Q8	748400	2076700	7 25	0 947	1 18	2 02	0 0777	0 603	0	0	6 43	0
11	4A6	6 5	44	S8	748200	2076700	7 22	1 04	1 17	1 85	0 0628	0 648	0	0	6 69	0
11	4A6	6 5	44	U8	748000	2076700	7 34	1 03	1 21	2 02	0 0799	0 611	0	0	6 91	0
11	4A6	6 5	44	U8	748000	2076700	7 37	1 12	1 23	2 01	0 0696	0 612	0	0	6 88	0
11	4A6	6 5	44	W8	747800	2076700	6 13	0 636	0 951	1 61	0 0666	0 52	0	0	5 26	0
11	4A6	6 5	44	I10	749200	2076900	7 76	0 772	1 14	1 72	0 0786	0 497	0	0	6 24	0
11	4A6	6 5	44	K10	749000	2076900	7 6	0 812	1 15	2 05	0 0721	0 521	0	0	6 3	0
11	4A6	6 5	44	M10	748800	2076900	7 92	0 942	1 14	1 7	0 0528	0 496	0	0	6 54	0
11	4A6	6 5	44	O10	748600	2076900	7 83	1	1 22	1 98	0 0583	0 574	0	0	6 8	0
11	4A6	6 5	44	Q10	748400	2076900	5 97	0 659	0 906	1 47	0 0593	0 494	0	0	5 37	0
11	4A6	6 5	44	S10	748200	2076900	7 93	0 959	1 14	1 82	0 0518	0 628	0	0	7 43	0
11	4A6	6 5	44	U10	748000	2076900	7 04	0 957	1 14	1 91	0 0697	0 667	0	0	6 41	0
11	4A6	6 5	44	W10	747800	2076900	6 01	0 831	0 944	1 59	0 0478	0 581	0 089	0	5 56	0
11	4A6	6 5	44	W10	747800	2076900	6 51	0 789	1 03	1 65	0 0759	0 648	0	0	5 79	0
11	4A6	6 5	44	I12	749200	2077100	7 95	0 991	1 15	1 72	0 0601	0 501	0	0	6 64	0
11	4A6	6 5	44	K12	749000	2077100	7 1	0 957	1 12	1 93	0 0709	0 533	0	0	6 43	0
11	4A6	6 5	44	M12	748800	2077100	7 43	0 958	1 16	2	0 0719	0 561	0	0	6 63	0
11	4A6	6 5	44	O12	748600	2077100	7 43	0 938	1 23	1 87	0 0642	0 591	0 075	0	6 71	0
11	4A6	6 5	44	O12	748600	2077100	7 38	0 849	1 18	1 9	0 0744	0 585	0	0	6 32	0
11	4A6	6 5	44	O12	748600	2077100	7 46	0 831	1 2	1 91	0 0765	0 594	0	0	6 36	0
11	4A6	6 5	44	Q12	748400	2077100	6 11	0 646	0 914	1 33	0 0559	0 522	0	0	5 48	0
11	4A6	6 5	44	S12	748200	2077100	6 99	0 908	1 14	1 81	0 0702	0 697	0	0	6 44	0

FOV = Field of View
m = meters
pCi/g = picoCuries per gram
μR/h = microRems per hour

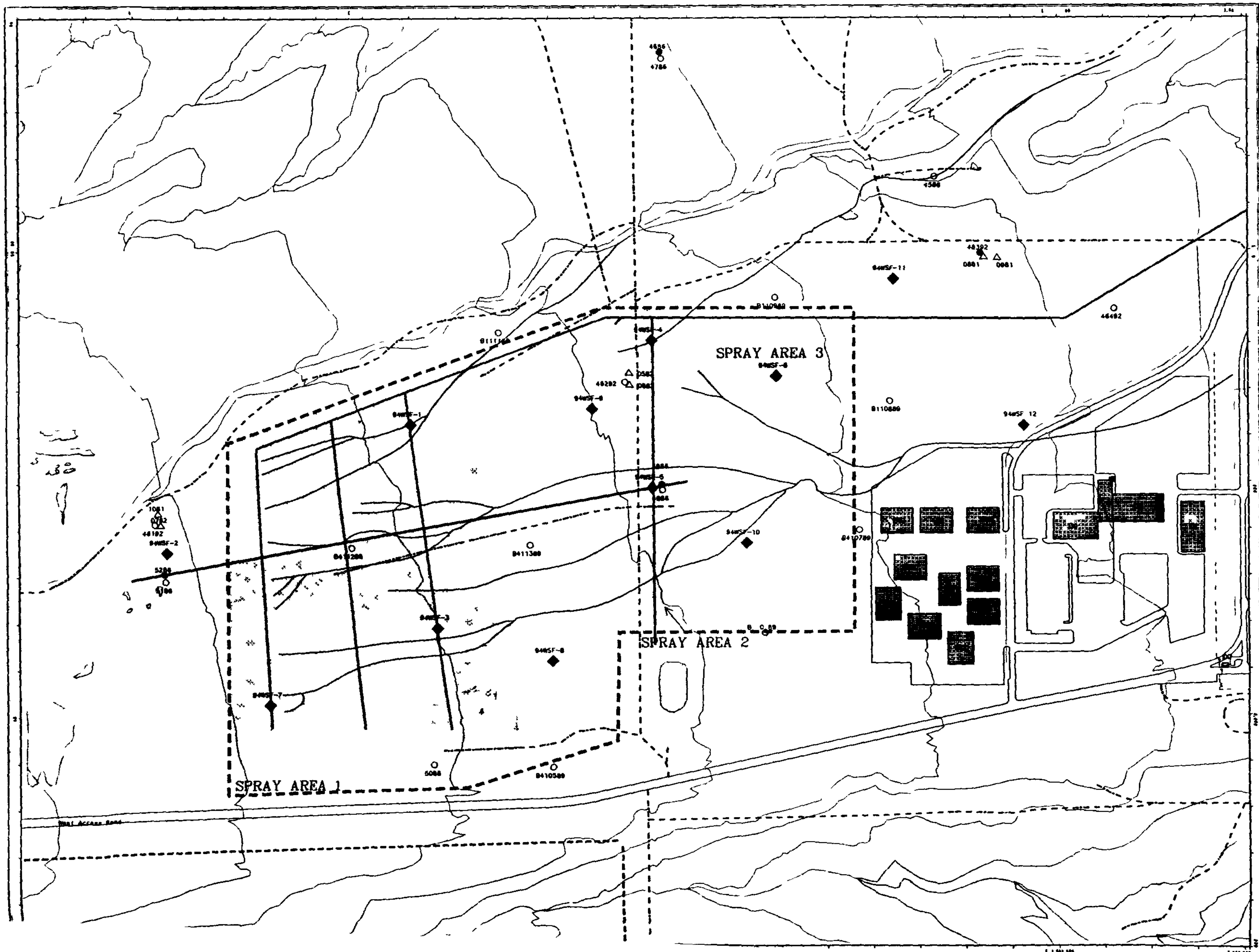
OU 11 HPGe RESULTS
(DRAFT)

OU	Detector Array	Detector Height (m)	FOV (m)	Station	North (feet)	East (feet)	K-40 (pCi/g)	Ra-226 (pCi/g)	Th-232 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Cs-137 (pCi/g)	Am-241 (pCi/g)	Pu-239 (pCi/g)	Exposure (µR/h)	% FOV Blocked
11	4A6	6 5	44	U12	748000	2077100	6 53	0 913	1 09	1 79	0 0617	0 67	0	0	6 15	0
11	4A6	6 5	44	W12	747800	2077100	6 9	0 857	1 05	1 74	0 0685	0 613	0	0	6 08	0
11	4A6	6 5	44	I14	749200	2077300	6 23	0 776	0 96	1 51	0 0604	0 401	0	0	5 5	0
11	4A6	6 5	44	K14	749000	2077300	7 25	0 935	1 12	1 97	0 0488	0 502	0	0	6 32	0
11	4A6	6 5	44	M14	748800	2077300	7 2	1 06	1 16	2 16	0 0497	0 592	0 139	0	6 83	0
11	4A6	6 5	44	M14	748800	2077300	7 48	0 739	1 21	2 23	0 0714	0 626	0	0	6 35	0
11	4A6	6 5	44	O14	748600	2077300	7 21	1 08	1 11	1 88	0 0426	0 55	0	0	6 69	0
11	4A6	6 5	44	Q14	748400	2077300	6 69	0 998	1 05	1 78	0 0618	0 622	0	0	6 36	0
11	4A6	6 5	44	S14	748200	2077300	6 23	0 637	0 977	1 79	0 0727	0 578	0	0	5 37	0
11	4A6	6 5	44	U14	748000	2077300	5 66	0 613	0 9	1 42	0 0686	0 586	0	0	5 09	0
11	4A6	6 5	44	W14	747800	2077300	6 56	0 628	0 915	1 5	0 0792	0 532	0	0	5 28	0
11	4A6	6 5	44	I16	749200	2077500	8 46	0 873	1 27	2 01	0 0747	0 532	0	0	6 77	0
11	4A6	6 5	44	K16	749000	2077500	7 28	0 766	1 12	1 81	0 0723	0 48	0	0	5 98	0
11	4A6	6 5	44	M16	748800	2077500	7 33	0 869	1 22	1 96	0 0848	0 613	0	0	6 47	0
11	4A6	6 5	44	O16	748600	2077500	7 25	0 889	1 25	2 09	0 0814	0 664	0	0	6 59	0
11	4A6	6 5	44	Q16	748400	2077500	8 02	0 842	1 3	2 24	0 0962	0 669	0	0	6 88	0
11	4A6	6 5	44	S16	748200	2077500	7 67	0 83	1 25	2 12	0 0946	0 709	0	0	6 7	0
11	4A6	6 5	44	U16	748000	2077500	6 24	0 736	1 02	1 85	0 0565	0 735	0	0	5 74	0
11	4A6	6 5	44	W16	747800	2077500	6 33	0 764	1 02	1 93	0 0681	0 774	0	0	5 83	0
11	4A6	6 5	44	ORW	752000	2078120	14 7	1 21	1 76	2 41	0 0688	0 273	0	0	10 3	0
11	4A6	6 5	44	E24	749600	2078300	7 33	0 856	1 13	2 02	0 0827	0 514	0	0	6 16	0
11	4A6	6 5	44	H24	749300	2078300	6 93	0 757	1 07	1 77	0 069	0 591	0	0	5 83	0
11	4A6	6 5	44	K24	749000	2078300	6 72	0 733	0 956	1 66	0 0614	0 494	0	0	5 54	0
11	4A6	6 5	44	N24	748700	2078300	6 29	0 809	0 97	1 43	0 0567	0 565	0	0	5 91	0
11	4A6	6 5	44	J25	749100	2078400	7 15	0 777	1 14	1 73	0 0847	0 638	0	0	6 15	0
11	4A6	6 5	44	M25	748800	2078400	6 32	0 768	1 01	1 55	0 06	0 645	0	0	5 77	0

FOV = Field of View
m = meters
pCi/g = picoCuries per gram
µR/h = microRems per hour


SPRAY AREA 1
SPRAY AREA 2
SPRAY AREA 3
West Access Road
OU11/IHSS-168 Bas. .ap
West Spray Field
Groundwater Potentiometric-Surface
Upper Hydrostratigraphic Unit
Figure 4-5
EXPLANATION
Spray Area
Bedrock Monitoring Wells
Alluvial Monitoring Wells
IHSS 168 (OU11)
Piping (Historical)
Seismic Line
Drainage Flow Line
Groundwater Potentiometric contours, feet above MSL
Approximate location of Potentiometric contours
Standard Map Features
Buildings or other structures
Lakes and ponds
Streams, ditches, or other drainage features
Fences
Contours (20' intervals)
Rocky Flats boundary
Paved roads
Dirt roads
U S Department of Energy
Rocky Flats Plant
Prepared by:
EG&G ROCKY FLATS
Rocky Flats Plant
P O Box 464
Golden, Colorado 80402-0464

OU11/IHSS-168 Basemap
West Spray Field
Proposed Monitoring Well Locations
Figure 4-2



EXPLANATION

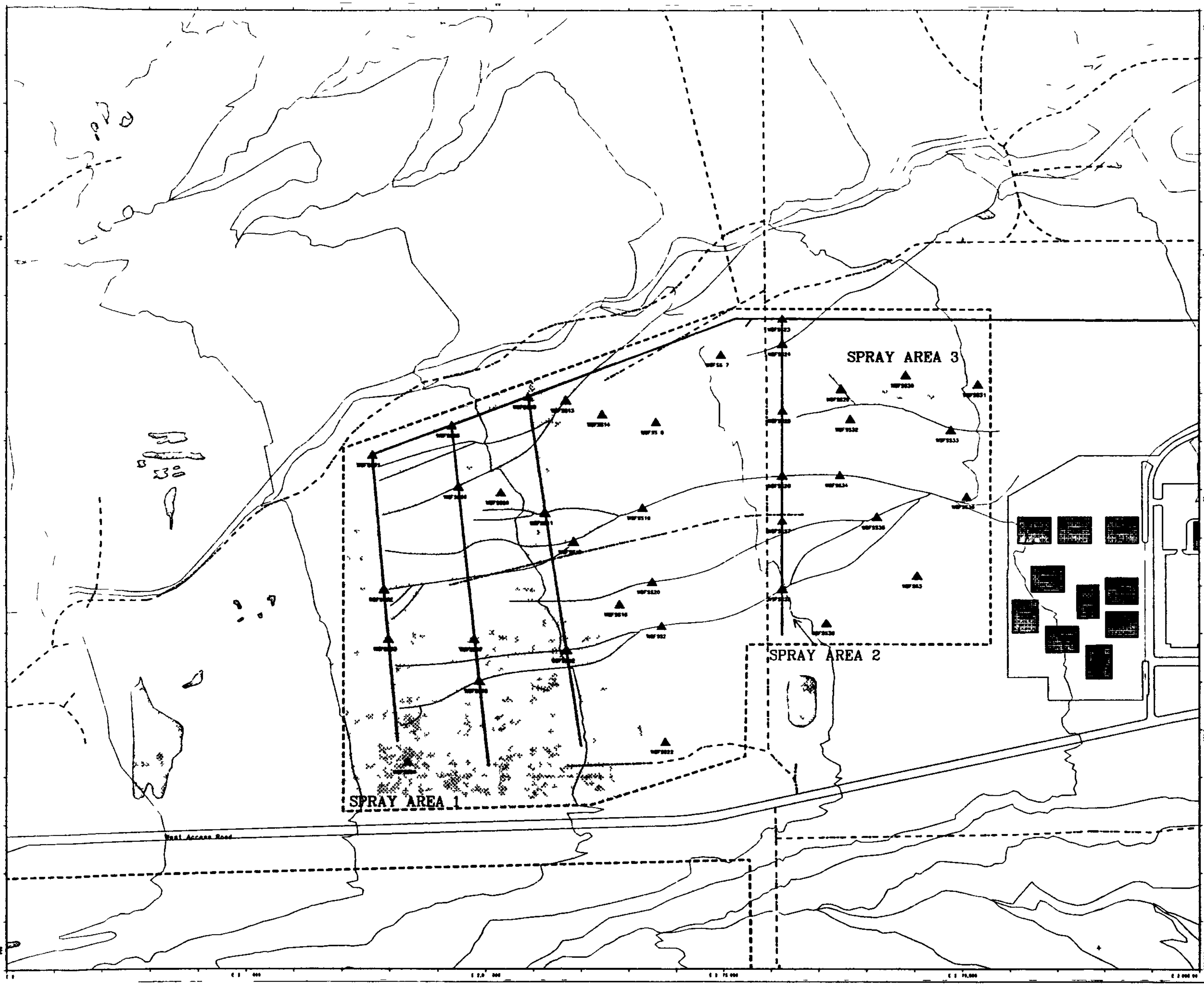
- Spray Area
- ◆ Proposed Monitoring Wells
- △ Pre-1986 Monitoring Wells
- ● Bedrock Monitoring Wells
- ○ Alluvial Monitoring Wells
- IHSS 168 (OU11)
- Piping (Historical)
- Seismic Line
- Drainage Flow Line

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20 Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

U S Department of Energy
Rocky Flats Plant

Prepared by
EG&G ROCKY FLATS
Rocky Flats Plant
P.O. Box 464
Golden, Colorado 80402-0464



OU11/IHSS-168 Basemap
West Spray Field
Proposed Surface Soil Sample Locations

Figure 4-1

EXPLANATION

- Spray Area
- ▲ Spray and Channel (11)
- ▲ Non-Spray and Channel (7)
- ▲ Spray and Non-Channel (10)
- ▲ Non-Spray and Non-Channel (8)
- ▲ Pipeline Junctures (4)
- IHSS 168 (OU11)
- Piping (Historical)
- Drainage Flow Line

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

U.S. Department of Energy
Rocky Flats Plant

Prepared by:
EG&G ROCKY FLATS
Rocky Flats Plant
P.O. Box 464
Golden, Colorado 80402-0464

Table 5-1
Field QA/QC Sample Collection Frequency

Activity	Frequency
Field Duplicate[1]	1 in 10
Field Preservation Blanks	1 sample per shipping container (or a minimum of 1 per 20 samples)
Equipment Rinsate Blank	1 in 20 or 1 per day[2] .
Triplicate Samples (benthic samples)[3]	For each sampling site
Source Water Blanks	1 sample per source
Trip Blanks[4]	1 per shipping container carrying VOC samples

1 For samples to be analyzed for inorganics
2 One equipment rinsate blank in twenty samples or one per day whichever is more frequent for each specific sample matrix being collected when non dedicated equipment is being used
3 For samples collected for tissue analysis
4 VOC sampling

OU 11 HPGe RESULTS
(DRAFT)

OU	Detector Array	Detector Height (m)	FOV (m)	Station	North (feet)	East (feet)	K-40 (pCi/g)	Ra-226 (pCi/g)	Th-232 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Cs-137 (pCi/g)	Am-241 (pCi/g)	Pu-239 (pCi/g)	Exposure (μR/h)	%FOV Blocked
11	4A6	6 5	44	H26	749300	2078500	7 85	0 867	1 23	1 82	0 0795	0 657	0	0	6 72	0
11	4A6	6 5	44	F27	749500	2078600	6 15	0 781	0 909	1 41	0 0503	0 445	0	0	5 41	0
11	4A6	6 5	44	K27	749000	2078600	7 25	1 02	1 26	2 05	0 0809	0 672	0	0	6 82	0
11	4A6	6 5	44	M27	748800	2078600	6 42	1 4	1 14	1 63	0 0193	0 695	0	0	7 3	0
11	4A6	6 5	44	H28	749300	2078700	8 08	0 892	1 3	2 16	0 0802	0 66	0	0	6 95	0
11	4A6	6 5	44	J28	749100	2078700	7 29	0 855	1 2	1 98	0 0838	0 69	0	0	6 55	0
11	4A6	6 5	44	K29	749000	2078800	7 19	1 01	1 23	2 01	0 0744	0 683	0	0	6 82	0
11	4A6	6 5	44	M29	748800	2078800	6 39	1 27	1 13	1 74	0 0269	0 621	0	0	6 88	0
11	4A6	6 5	44	F30	749500	2078900	7 12	0 959	1 11	1 87	0 063	0 521	0	0	6 42	0
11	4A6	6 5	44	H30	749300	2078900	7 05	0 858	1 2	1 84	0 0897	0 674	0	0	6 39	0
11	4A6	6 5	44	J30	749100	2078900	7	0 812	1 15	1 95	0 0734	0 705	0	0	6 34	0

FOV = Field of View
m = meters
pCi/g = picoCuries per gram
μR/h = microRems per hour

TABLE 5-2
SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES
FOR OU 11 SAMPLES

MATRIX	PARAMETER	CONTAINER	PRESERVATIVE	HOLDING TIME
SOIL	TAL Metals	1X8 oz wide-mouth glass jar	none	6 months (28 days for mercury)
	Nitrate/Nitrite	8 oz wide mouth glass with Teflon®-lined closure	H2SO4, pH<2	28 days
	TCL Volatiles	1 X 125 ml wide-mouth Teflon lined jar	Cool, 4 degrees C out of sunlight	7 days
	TCL Semivolatiles	1 X 250 ml wide-mouth Teflon-lined jar	Cool, 4 degrees C out of sunlight	7 days until extraction, 40 days after extraction
	Radionuclides	500 mL wide-mouth glass jar	none	none
WATER	TCL Volatiles	40 ml amber glass bottle with TFE silicon septa	Cool, 4 degrees C, out of sunlight	7 days
	TCL Semivolatiles	1 liter amber glass bottle with Teflon lined closure	Cool, 4 degrees C, out of sunlight	7 days until extraction, 40 days after
	Nitrate/Nitrite	2 L/P, glass	1 1 Sulfuric Acid, pH<2, Cool, 4 degrees C	28 days
	Radionuclides	3 X 4 L plastic containers (for full suite)	HNO3	6 months
	TAL Metals	1 X 1 L polyethylene bottle	nitric acid pH<2	6 months

MEMORANDUM

TO: Connie Dodge

FROM: Fred Grigsby

DATE: May 9, 1994

SUBJECT: Comments regarding HR seismic data, West Spray Field

Upon reviewing the procedures used by Ebasco to obtain the high resolution reflection data across the West Spray Field it appears that they achieved some of their objectives but probably overestimated the effectiveness of the survey in delineating channels in the Rocky Flats Alluvium. In Section 3.4 of the final report it was stated that because of the deeper alluvium, a noise analysis was run to determine what spread length, shot point spacing and geophone spacings should be incorporated in running the survey. The stated objectives were to allow for better resolution of structure and deeper horizons, and to improve the resolution of dipping geologic beds. As a result of the analysis the spread length was increased to 380 feet, with a far offset of 332 feet. The shot point spacing was increased to 4 feet, as was the geophone spacing, and the CDP fold was doubled to 48. Although a copy of the noise analysis (Walkaway or Expanded Spread) was not included in the report, it can be assumed that a window for deep reflections existed within the selected spread length. With the increase in CDP stacking, which would incorporate only a minimum amount of moveout correction, the deeper reflections should be significantly enhanced so that features such as the dips shown by the deeper reflection on the west end of the line and the indicated truncation of beds with the base of the alluvium are considered reliable.

Several reflectors are indicated in the alluvial section which have been used to interpret inferred alluvial channels. A comparison of the logged alluvial section of bore hole 42392, which is located on the seismic line and was drilled after the data was obtained, indicate that these reflectors are not reliable. This hole was logged in detail and shows a 100 foot thick section of Rocky Flats Alluvium that varies only in the sand to gravel ratios (gravel ranges from 35 to 60%, and averages 70% in the lower 20 feet of the section)and are gradational. It seems unlikely that velocity interfaces will exist that could produce the reflections that are shown on the section at the location of the bore hole. Overall the section described in hole 42392, and the alluvial sections described in detail in holes 46192 and 46292 (located off of the west and east ends of the seismic line) indicate an extensive alluvial section that grades laterally into facies that vary only in their sand to gravel ratios which are similar to those shown above. It is not likely that this type of alluvial section would result in the continuous reflections as shown on the seismic section. It seems probable that the reflections shown on the section may be the results of over processing and/or stacking.